Title: Phase Change Material Trade Study: a Comparison Between Wax and Water for Manned Spacecraft

Gregory Quinn Hamilton Sundstrand
Ed Hodgson Hamilton Sundstrand
Ryan Stephan NASA Johnson Space Center

Phase change material heat sinks have been recognized as an important tool in optimizing thermal control systems for space exploration vehicles and habitats that must deal with widely varying thermal loads and environments. In order to better focus technology investment in this arena, NASA has supported a trade study with the objective of identifying where the best potential pay-off can be found among identified aqueous and paraffin wax phase change materials and phase change material heat sink design approaches. The study used a representative exploration mission with well understood parameters to support the trade. Additional sensitivity studies were performed to ensure the applicability of study results across varying systems and destinations.

Results from the study indicate that a water ice PCM heat sink has the potential to decrease the equivalent system mass of the mission's vehicle through a combination of a smaller heat sink and a slight 5% increase in radiator size or the addition of a lightweight heat pump. An evaluation of existing and emerging PCM heat sink technologies indicates that further significant mass savings should be achievable through continued development of those technologies. The largest mass savings may be realized by managing the location of the liquid and the solid in the heat sink to eliminate the melting and freezing pressure of wax and water, respectively, while also accommodating the high structural loads expected on future manned launch vehicles.